Norfolk CSO Sediment Remediation Project
Closure Report

Elliott Bay/Duwamish Restoration Program

Prepared for the
Elliott Bay/Duwamish Restoration Program Panel
by the
King County Department of Natural Resources

Panel Publication 21

August 1999

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with the assistance of EcoChem Inc.
and team members
Black & Veatch Corporation,
Hartman Consulting Corporation,
Anchor Environmental, L.L.C.

Panel Publication 21

Elliott Bay/Duwamish Restoration Program
NOAA Damage Assessment and Restoration Center Northwest
7600 Sand Point Way NE
Seattle, WA 98115-0070

(206) 526-4338
(FAX) (206) 526-4321

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Individuals and organizations needing further information about the Elliott Bay/Duwamish Restoration Program should contact the Administrative Director at the following address and telephone number:

Dr. Robert C. Clark, Jr., Administrative Director
Elliott Bay/Duwamish Restoration Program
NOAA Damage Assessment and Restoration Center Northwest
7600 Sand Point Way NE
Seattle, WA 98115–0070
(206) 526-4338 FAX: (206) 526-4321

The Panel of Managers holds regularly scheduled meetings that are open to the public. Technical Working Group and committee meetings are scheduled on an as-needed basis, and are also open to the public. Meetings are generally held at the National Oceanic and Atmospheric Administration, National Marine Fisheries Service - Regional Directorate Conference Room, Building 1, 7600 Sand Point Way NE, Seattle. The Panel recommends that you contact the Administrative Director at the above phone number to confirm meeting schedules and locations. The panel also holds periodic special evening and weekend public information meetings and workshops.

General Schedule for Panel and Committee Meeting Dates

Panel: quarterly, first Thursday of January, April, July, October, 9:30 A.M. - 12:30 P.M.
Habitat Development Technical Working Group: third Thursday of every month, 9:30 A.M. - 12:30 P.M.
Sediment Remediation Technical Working Group: scheduled as needed.
Public Participation Committee: scheduled as needed.
Budget Committee: scheduled as needed.

Environmental Review of Specific Projects

Formal hearings and comment periods on appropriate environmental documents for proposed sediment remediation and habitat development projects will be observed. Please contact the Administrative Director for more information.

This information is available in accessible formats on request at (206) 296-0600 (voice) and 1-800-833-6388 (TTY/TDD users only).

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1.0 Introduction

This Closure Report documents the work performed during the sediment remediation project at the Norfolk Combined Sewer Overflow (CSO) outfall site on the Duwamish River in Seattle, Washington. It describes the dredging, transport, and disposal methods that occurred between February 1999 and April 1999.

1.1. BACKGROUND

To implement the requirements of the 1991 Consent Decree defining the terms of a natural resources damage agreement, the Elliott Bay/Duwamish Restoration Program (EBDRP) was established. Program oversight is provided by the EBDRP Panel, which is composed of federal, state, and tribal natural resource trustees, the Municipality of Metropolitan Seattle (which subsequently became part of King County government and is now the King County Department of Natural Resources [KCDNR]), and the City of Seattle (City). The goals of the EBDRP include remediation of contaminated sediments associated with KCDNR and City CSOs and storm drains; restoration of habitat in Elliott Bay and the Duwamish River; and control of potential sources from the outfalls.

In 1992, a Sediment Remediation Technical Working Group (SRTWG) was established by the EBDRP Panel to address contaminated sediment issues. Ultimately, the SRTWG selected four sites (Duwamish Pump Station CSO and Diagonal Way CSO/Storm Drain; Norfolk CSO; Pier 53-55; and Seattle Waterfront) for further investigation. This Closure Report addresses only the Norfolk CSO outfall site.

In 1994, a plan to investigate the extent of contamination at the Norfolk CSO was prepared by KCDNR (then Metro) on behalf of the EBDRP Panel. KCDNR implemented field data collection activities described in the Sampling and Analysis Plan/Addenda between August 1994 and December 1995. The primary goals were to determine the extent of sediment contamination around the Norfolk CSO outfall, based on comparison to Sediment Management Standards (SMS) criteria and to determine a preferred remedial alternative for the site. The results of this effort are presented in the *Norfolk CSO Sediment Cleanup Study* (EBDRP, 1996a). The preferred remedial alternative included mechanical dredging of the contaminated sediments; placement of these sediments in barges; transporting the contaminated sediments to a cement manufacturing company for treatment (or transport to a Subtitle D Landfill for disposal if the cement kiln would not accept the sediment) and transporting the hazardous sediments to a Subtitle C landfill; and backfilling the site with clean sediments to provide similar habitat for the natural biota in the area. The project was put out to bid in early 1998. No contractor bids were received due to concern over high flows during the winter, penalty clauses, and insufficient commitment from the local cement kiln. The project was modified to allow all sediments to be disposed of at upland landfills. The project was rebid in October 1998 with incentive clauses rather than penalty clauses. This Closure

Report discusses the construction activities performed for the implementation of the cleanup.

1.2. OBJECTIVES

The objective of the project is to remove the contaminated sediment associated with past discharges from the Norfolk CSO plus some additional nearby contaminated sediments that may have originated from other and unidentified sources, from the environment.

2.0 Construction Activities

2.1. TIMELINE

The Norfolk Sediment Remediation Project was advertised in the Seattle Daily Journal of Commerce. A pre-bid conference was held on October 20, 1998 in Conference Room 11A of the Exchange Building at 821 Second Avenue, Seattle. Sealed bids were required to be submitted to King County at the 12th floor Contracts Counter of the Exchange Building by 2:00 p.m. on October 29, 1998. General Construction Company (General) was selected as the Prime Contractor and Notice to Proceed was issued on December 21, 1998. The Contractor began mobilizing his equipment to the site on January 4, 1999, constructing support facilities on January 6, 1999, and dredging on February 3, 1999. Dredging was completed on March 16, 1999. Backfilling of the dredged area commenced on March 17, 1999 and was completed on March 30, 1999. The Contractor finished removing the in-water portion of the temporary ramp on April 1, 1999, and cleaned up the upland portion of the site by April 6, 1999. A punch list was developed on April 12, 1999 and was completed on April 31, 1999.

2.2. CONTRACTOR SELECTION

Five bids were received and were opened on October 29, 1998. The apparent low bid was rejected because the Contractor proposed using a hydraulic dredging system that was not in compliance with the Technical Specifications (KCDNR 1998). The winning responsive bid was submitted by General Construction Company for $1,132,850. The Engineer's estimate for this project was $1,096,000. The Contractor also included Foss Environmental Services as a subcontractor responsible for the upland portion of the site.

2.3. GENERAL CONSTRUCTION PROCEDURES

The Contractor mobilized equipment to the site and installed survey controls along the Duwamish River channel bank. The Contractor set up the upland staging area including office trailers, dewatering facilities, and perimeter fencing. He constructed a ramp to load the crane onto the barge and to use for sediment handling (Photo 1). Once the crane was set on the work barge, dredging began (Photos 2 and 3) in the upstream portion of the area identified as "Likely Hot Spot" on the Contract Drawings. The dredging location was determined using cables connected to survey controls along the north river bank (Photo 4). The barge was positioned using winches to adjust the distance from four anchor positions upstream and downstream of the dredging area. The hotspot dredging was conducted in approximately 50-cubic yard (cy) volumes referred to as disposal units. These disposal units were kept separated on the barge and individually off-loaded from the barge to the ramp (Photo 5) and then placed in individual and isolated dewatering cells (Photos 6, 7, and 8). Each disposal unit was tested to determine an average PCB concentration. Disposal of sediment was based on whether the average concentration of each disposal unit was above or below the hazardous waste concentration of PCBs. Sediment that contained less than 45 parts per million dry weight (ppm DW) of PCBs was trucked to Olympic View landfill in Bremerton, Washington. Sediment that contained 45 ppm of PCBs or greater was trucked to a hazardous waste landfill in Arlington, Oregon operated by Chemical Waste Management of the Northwest. Fly ash was mixed into the sediment (Photo 9) and placed on top of the loaded trucks to absorb free water. Plastic liners made trucks water-tight and were folded over the top of the load for transport.

Dredging of the hotspot continued until samples of the sediment contained less than 45 ppm of PCBs. Once all of the hotspot sediment was dredged, then the remainder of the sediment was dredged. This sediment was dredged in bulk, and not segregated into 50 cy disposal units and was trucked to the Olympic View landfill (Photo 10). Large woody debris taken during the dredging was chemically tested for PCBs and was trucked to Olympic View landfill (Photo 11). Dredging commenced from upstream to downstream to the depths required by the Contract Documents. After dredging was complete, a survey of the post-dredge sediment surface was performed to confirm that the depth required on the Contract Drawings was obtained. After dredging, equipment was decontaminated and dredge depths approved, the Contractor proceeded with backfilling the site. Clean backfill material was acquired from a downstream source. This backfill material was barged up river under a low bridge (Photo 12) and off-loaded using the crane that performed the dredging (Photos 13 and 14). The backfilling continued until the elevations required by the Contract Drawings were achieved (Photo 15). The Contractor then demobilized his equipment. The crane was offloaded from the barge to a truck using the ramp. Then the barges were shipped to the next project site. The ramp and dewatering facilities first underwent a decontamination process (Photo 16) and then were dismantled, the trailers and temporary fencing removed, and finally the parking lot and pathway cleaned and restored.

2.4. EQUIPMENT AND LAYOUT

Upland support equipment/facilities included a 10-by-32-ft construction trailer, 2 sani-cans, an 8-by-20-ft conex (equipment storage container), a 400-amp diesel-powered welder, two front-end loaders, two half-ton pickup trucks, and a 500-gallon diesel tank (which was later replaced by a 250-gallon tank). The upland portion of the site was surrounded by a temporary cyclone fence with the pre-existing jogging path rerouted around the perimeter of the site. The sediment dewatering/containment portion of the uplands was approximately 70 ft by 200 ft and was lined with a continuous piece of 10-oz impermeable liner with filter fabric underneath against the asphalt. On top of the initial liner, the area where sediments were stored and dewatered was covered with an impermeable 40-mil HDPE liner. Plastic (10-mil polyethylene) covered ecology blocks were used to bound the containment portion of the site and to provide the internal divisions for the discrete 50-cy cells used to segregate hotspot sediments for testing and disposal. After the hotspot was dredged this area was reconfigured using steel plates over the 40-mil liner. Additionally, a secondary containment berm was constructed outside of the primary containment area consisting of 10-oz fabric with 10-mil polyethylene. Water was allowed to pass from the primary sediment containment area through filter fabric and hay bales to a water collection area where it was pumped into a Baker tank. Initially, the Contractor used two 4,000 gallon Baker tanks but later exchanged one of these tanks for a 20,000-gallon tank, leaving the second 4,000-gallon tank for back-up. This water was periodically pumped into a vactor truck, which transported the water (after testing) to a King County sanitary sewer. See Figure 1 for upland layout configuration.

A 26-by-60-ft timber ramp was constructed on six temporary 24-inch steel pipe piles. The timber ramp was used to load the crane onto the barge and was used to offload and transfer dredged sediments to the upland dewatering facility. Four additional 24-inch piles were installed on the offshore end of the ramp to tie up the barge at the end of each work day. The pipe piles were installed and removed with a vibratory hammer. Steel I-beams were placed as pile caps, and stringers with 12-by-12-inch timbers were placed as the decking material. The portion of the ramp that was located over the river was sloped at a 1.5 percent grade toward the river to allow for limited dewatering on the ramp. The ramp was surrounded on three sides by jersey barriers. Filter fabric and steel plates were placed on the ramp surface. On the outboard end, the jersey barriers were set up on wooden pallets twice-wrapped with filter fabric; hay bales were placed up against the barrier/pallet arrangement. On the inboard end, an impermeable liner (40-mil HDPE) was placed between the steel plates and filter fabric. Additionally, steel plates, placed side by side, provided a surface for front-end loaders to drive on from the ramp to the containment/dewatering area. Sediments were transported from the ramp to the adjacent dewatering/containment facility using either Caterpillar 966 or Volvo L70C front-end loaders. Sediments were later loaded into 10-cy dump trucks with 10-cy trailers (truck and pup) for transport to the landfills.

The Contractor used a 16-ft steel skiff with an outboard motor to transfer personnel from the beach to the dredge as needed. A mechanical clamshell dredge was used to remove contaminated sediments and place backfill. The dredge consisted of an American 9260 125-ton crawler crane equipped with a 4-cy bucket, and this crane was mounted on a 164-by-50-ft barge (GC 101). The barge was moved by pulling on winches connected to 4 anchors, which were placed out near the banks of the river near the upstream and downstream bridges. Dredged material was placed on both ends of this barge. During hotspot removal the barge was configured with jersey barriers to divide each end of the barge into three cells (6 cells total). Dewatering on the barge was allowed, but only through filter fabric material. Free water passed through 3 layers of filter fabric in series with hay bales before entering the river. See Figure 2 for barge layout configuration.

2.5. DREDGING OPERATIONS

The dredge cut plan is shown in Figure 3. Dredging was performed in three different phases. The area defined as the potential PCB hotspot was dredged first and isolated in approximately 50-cy quantities for chemical testing. Upon completion of the hotspot dredging, the remaining contaminated sediments were dredged and did not require special segregation or chemical testing. After these two phases were completed, confirmational testing was performed (Section 3.4) and additional sediments were dredged until either no exceedences were measured or until slope stability issues precluded additional sediment removal to a greater depth.

2.5.1 Hotspot Removal

Samples from the discrete 50-cy quantities (disposal units) were collected and submitted to the King County Environmental Laboratory for PCB analysis. Results were obtained within 48 hours. The results of the chemical tests were then used to determine the appropriate disposal facility. The Toxic Substance Control Act (TSCA) (40 CFR 761.60) requires that "all dredged materials … that contain PCBs at concentrations of 50 ppm or greater shall be disposed of … in a chemical waste landfill which complies with section 761.75." For this project, sediments with PCB concentrations greater than 45 ppm DW were sent to the Subtitle C landfill in Arlington Oregon. Sediments represented by samples with PCB concentrations less than 45 ppm were disposed of in the Subtitle D landfill in Kitsap County.

Hotspot dredging occurred over 9 working days with approximately 1,850 cy dredged. This is an average production rate of approximately 200 cy/day. The Contractor encountered more debris than he had anticipated. Most of the debris were large logs or stumps that tended to be located near the shore, or rock from the rock pile identified on the plans. There was very little anthropogenic debris. The dredging Contractor was also limited by the capacity and effectiveness of the sediment dewatering facility setup by the upland subcontractor. The Contractor's dewatering facility did not effectively dewater the fine-grained sediments with higher water content. The upland subcontractor added fly ash and/or saw dust to absorb excess water from the sediments.

A total of 582 tons of fly ash and saw dust were used to absorb excess water from the hotspot sediments. The upland subcontractor initially tried to blow the fly ash into the containment area. Due to the trouble in controlling the amount of airborne fly ash, this practice was modified to having a loader scoop the fly ash from a stockpile, haul it to the containment cell, and manually mix the fly ash and sediment.

The sediment dewatering process was not significantly affected by the heavy rains that occurred during this time as the sediments in the dewatering facility were covered with plastic tarps; however, one of the 4,000-gallon Baker tanks was replaced with a 20,000 gallon tank to handle the additional rain water that was collected and contained within the upland staging area. The collected water from the dewatering facility (and rainfall that ran off the tarps) was collected and stored in a Baker tank. When the tank was almost full, water samples were collected from the tank for chemical analysis of arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, PCBs and total suspended solids (TSS). None of the water samples exceeded the maximum concentrations allowed by the King County sewer system discharge permit. The upland subcontractor then brought in his vactor truck, pumped out the Baker tank, hauled the water to a King

County sanitary sewer manhole located at the intersection of East Marginal Way South and South 104th Street and pumped the water into the sewer.

2.5.2 Contaminated Sediment Removal

Dredging methods for contaminated sediments were very similar to the hotspot dredging except that sediments were not segregated into 50-cy units. Approximately 150 cy of dredged sediments were placed in each end of the barge, offloaded onto the ramp and then placed into the sediment dewatering/containment area. The dewatering/containment area had been reconfigured to remove the 50-cy isolation cells. Steel plates were also placed on top of the fabric and impermeable liner to minimize damage to the liner.

Approximately 2,200 cy were removed during the 7 days of contaminated sediment dredging. This is an average production rate of 320 cy/day. Debris, including trees and stumps, were encountered during contaminated sediment dredging activities. Because sediments were not required to be placed in the 50-cy units, they were handled in the upland area more quickly and efficiently during this phase of the work as evidenced by time spent offloading the barge by the dredging Contractor. He offloaded his barge for an average of 2.3 hours per day versus an average of 3.5 hours per day during the hotspot removal phase while handling 60 percent more material. (See Appendices B and C for the Contractor's and Inspector's Daily Reports.)

A total of 418 tons of fly ash was used to absorb excess water from the sediments dredged during the contaminated sediment removal phase. Fly ash was manually mixed with the sediment as described in Section 2.4.1.

2.5.3 Confirmational Testing Phase

During confirmational testing (Section 3.3) exceedences of cleanup standards were observed. The Contractor was directed to return to these areas and remove an additional 3 feet of material. Sediments from locations that measured greater than 45 ppm DW for total PCBs during confirmational sampling, were isolated from the other sediments. These sediments were not tested further, and were sent directly to the appropriate landfill (Section 2.5). After the 3 feet of material was removed, additional samples were collected. In some of the areas, the results from the analyses of samples indicated the sediments still contained concentrations of chemicals exceeding Sediment Management Standards (SMS; Chapter 173-204 WAC) chemical criteria. The Contractor was directed to return again to these areas and remove another 3 feet of sediment. The newly exposed sediment surface was tested. In 4 areas, this second 3 feet of sediment removal still did not remove all of the sediment exceeding SMS criteria. After discussing these results with EBDRP Panel members (including appropriate regulatory agencies), it was decided to remove only one more 3-foot thick layer because of concern for the stability of the shoreline.

2.6. DISPOSAL AND WEIGH TICKETS

Once sediments were sufficiently dewatered (or had fly ash added to minimize free water) they were loaded into lined dump trucks. The loads were covered with tarps and the trucks were sent to a landfill. Sediments dredged during the contaminated sediment phase were sent to the Olympic View Sanitary Landfill in Bremerton, WA. The appropriate landfill was determined for sediments dredged during the hotspot removal phase and the confirmational phase based on testing performed by the King County Environmental Laboratory. If PCB concentrations were 45 ppm DW or greater, all sediments from that cell were taken to the hazardous waste landfill in Arlington, OR. Sediments with PCB concentrations less than 45 ppm were sent to Olympic View.

Based on the weigh tickets obtained at the landfill, a total of 2,314.10 tons of sediment were sent to Arlington and 5,985.57 tons were sent to Olympic View. These quantities include the 999.62 tons of fly ash and saw dust used to dry out the wet sediments.

2.7. DECONTAMINATION

The front-end loaders and upland ecology blocks and jersey barriers were decontaminated using pressure washers within the sediment containment area. The water was collected and disposed of with other water collected from the sediments. The interior of the barge, jersey barriers, and the clamshell were cleaned on the barge with a pressure washer. The water was allowed to drain through hay bales and three layers of filter fabric into the river. Surfaces that would potentially be contacted by people (e.g. the interior of the crane) were wiped clean with a kerosene wipe followed by a final wipe of cleanser.

2.8. BACKFILL OPERATIONS

Backfill material (clean sand) was obtained from the turning basin located immediately downstream of the site. The turning basin was undergoing its biannual dredging by the U.S. Army Corps of Engineers (Corps). The Corps' contractor, A. H. Powers, made these sediments available to General for backfill. The turning basin sediments had been tested in October 1998 for open water disposal and were determined to be suitable for unconfined open water disposal. Prior to placing this backfill material, a sample was submitted to the King County Laboratory for chemical analysis. The results of these tests are discussed in Section 3.2.2.

The backfill material was placed using the decontaminated 4-cy bucket and American 9260 125-ton crane used to dredge the site. The sand backfill was placed by releasing the material over the intended location using a sweeping motion to provide even coverage of the site.

3.0 Compliance Monitoring

The Model Toxics Control Act (MTCA) requires three different types of compliance monitoring be performed to confirm the adequacy of the remedial action (WAC 173-340-410). These include protection monitoring, performance monitoring, and confirmational monitoring. The compliance monitoring performed during the Norfolk Sediment Remediation project is discussed in this section.

3.1. PROTECTION MONITORING

Protection monitoring is performed to confirm that human health and the environment are adequately protected during construction of the cleanup action as described in the project specific safety and health plan (WAC 173-340-410(a)).

No deviations from the Contractor's health and safety plans were reported or observed. General reported sending an employee for medical attention due to nasal irritation on February 11, 1999. The doctor prescribed some medication to control the irritation. The cause of the irritation is unknown. A dump truck travelling to the Olympic View landfill on February 9, 1999 apparently spilled some water onto a nearby vehicle. The truck returned to the site, the load was removed and was further dewatered. It was reported that the water was likely generated by vibrations caused from the truck traveling down the road. The owner of the private vehicle did not request any action from the County.

The Contractor performed limited air monitoring during fly ash mixing operations to determine whether airborne levels of total- and respirable-particulate and crystalline quartz exceeded the applicable Washington State Industrial Safety and Health Act (WISHA) Permissible Exposure Limits (PEL). Samples were collected over a 5 to 6 hour period from locations down wind of the operations. The monitoring results showed that time-weighted averages of airborne levels of total particulate, respirable particulate and crystalline quartz did not exceed the PELs on the day of sampling. The report, prepared by Schumacher & Associates, Inc. (Schumacher & Associates 1999), is included in Appendix F.

Chain-of-Custody manifests for each truckload of sediment transported to the Subtitle C landfill were used to document the successful delivery of hazardous sediment for the permitted disposal.

Water quality monitoring of the Duwamish River was not required in the Hydraulic Project Approval permit issued by the Washington Department of Fish and Wildlife. Therefore, no monitoring in the river was performed. The collected water from the sediment dewatering facility was tested for TSS, PCBs, and metals prior to discharging this water to the King County sanitary sewer system. No exceedences of the discharge permit-required concentrations were found. Sampling and testing of this water is discussed further in Section 3.2.3.

3.2. PERFORMANCE MONITORING

Performance monitoring is conducted to confirm that the cleanup action has attained cleanup standards or other performance standards (WAC 173-340-410 (b)).

3.2.1 Post-Dredge and Post-Backfill Surveys

The post-dredge and post-backfill surveys showed that the Contractor removed sediments to the minimum required elevations shown in the Contract Drawings and as described in the Technical Specifications and that the backfill was placed in accordance with the

Contract Drawings and Technical Specifications. Average dredge cuts were designed to be 3 to 5 feet thick (including a one-foot overdredge allowance) and backfill was to be approximately 4 feet over the dredge cuts with a two-foot allowable tolerance. The Contractor had good location control and generally met these requirements. Surveys are discussed further in Section 4.0 and included in Appendix E.

3.2.2 Dredged Sediment, Woody Debris, and Backfill Sampling and Analysis

During the dredging process, sediment samples were collected by King County Laboratory staff and analyzed for PCB concentrations to determine the appropriate disposal destination for dewatered sediments. Previous analytical results during the Norfolk site investigation indicated the potential for sediment PCB concentrations that might exceed 50 ppm DW, the hazardous waste limit under the Toxic Substances Control Act (TSCA).

After each day's dredging, sediment samples were generally collected directly from the barge prior to off-loading to the dewatering area. Samples were collected from each of the six 50-cy disposal units on the barge. Anywhere from one to six disposal units were filled on a given day. On a few occasions, samples were collected after the sediment was off-loaded to the dewatering area.

Sediment samples were comprised of from three to six discrete aliquots collected at different locations within each bin representing a disposal unit. The number of aliquots was based on field observations regarding the apparent grain size distribution throughout the bin. The samples were composited using pre-cleaned, stainless steel bowls and spoons and placed into laboratory-supplied sample containers. A dedicated set of sampling equipment was used for each bin, mitigating the need for field decontamination of equipment.

Samples were placed into an ice-filled cooler until delivery to the King County Environmental Laboratory for analysis. Samples were delivered under chain-of-custody the same day as collected and maintained as such throughout the analytical process.

Sediment samples were analyzed for total PCBs by EPA Method 8082 on a 48-hour turnaround. Results are provided in Table 1 and are representative of locations shown in Figure 6. Analysis was generally completed within 24 hours, however, the high concentrations of PCBs frequently necessitated reanalysis of the sample extract in a diluted state. Quality Control (QC) samples analyzed with the test samples included method blanks, spike blanks, laboratory duplicates, and matrix spikes. All QC results were within recommended control limits throughout the course of the dredging phase of the project. The concentrations reported for total PCB may be biased high because of the way that individual Aroclors were quantified, resulting in a degree of double counting. Review of the chromatograms from the analyses indicated that the PCBs were primarily Aroclor 1016 and/or weathered Aroclor 1248, and that contributions from Aroclors 1254 and 1260 were less. Thus, the results presented herein are qualified as estimated (J).

Sample PCB concentrations were reported on a dry-weight basis, based on analysis of total solids concurrent with PCB analysis. Samples with a PCB concentration of greater than 45 ppm DW indicated that dredged material from the corresponding bin should be shipped to a Subtitle C landfill for disposal. Samples with a PCB concentration less than 45 ppm indicated that the corresponding dredged material should be shipped to a Subtitle D landfill. Although TSCA specifies a concentration of 50 ppm as hazardous waste, it was felt that a concentration "cut-off" of 45 ppm would provide an extra margin of safety.

Woody debris was also brought ashore during the dredging process and stockpiled in the dewatering containment area. Prior to disposal, samples were collected and analyzed for PCBs. Results are provided in Table 2. Samples were collected using a variety of dedicated, pre-cleaned instruments: stainless steel spoons and knives to take "scraping" samples of bark and sediment; and hammers and chisels to collect interior wood. Two samples were collected from mixed sediment and bark to evaluate PCB concentrations on the exposed surface of the woody debris and two samples were collected from interior wood to evaluate the mobility of PCBs through the debris. These samples were analyzed for PCBs and total solids in the manner described above. No samples exceeded TSCA limits so all woody debris was disposed of at the Olympic View Sanitary Landfill.

Sediment dredged from the Duwamish River Turning Basin was analyzed by the Corps. Chemical results are provided in Table 4. These results indicated that the sediment met sediment criteria for unconfined open water disposal based on the Dredged Material Management Program Screening Level criteria. The Corps had performed bioassays on 3 composite sediment samples and only one sampled failed the larval test that represented an SQS exceedence. However, the Norfolk project team considered the bioassay results to be inconclusive and decided to perform chemical analysis of the backfill after it was dredged and placed on the barge. Therefore, a composite sample was collected by King County from the barge of backfill sediment prior to placement at the site. The results shown in Table 5 indicated that the sediment criteria were met for all analytes, except for four compounds that had reported detection limits exceeding one or all of the sediment criteria. The detection limits were less than 50 ug/Kg for all of these analytes, which is less than routine reporting limits. This indicated the laboratory obtained good detection limits, but the sediment criteria are lower than achievable with the sample size used by the laboratory. Because the detection limits that exceeded the criteria were not for chemicals of concern at the site, the backfill was determined to be adequate for site purposes.

3.2.3 Sampling and Analysis of Baker Tank Water

Water collected during the sediment dewatering process was collected and stored in a Baker tank. Prior to the initial discharge of the accumulated water to the sanitary sewer system, one sample was collected and analyzed for chemical and physical constituents required by the project's King County Industrial Waste discharge authorization.

The sample was collected by lowering a clean, stainless steel bucket through an opening in the top of the tank to capture an aliquot of the water. The sample was placed into pre-cleaned, laboratory-supplied containers and delivered to the King County Environmental Laboratory under chain-of-custody for 24-hour analysis.

The sample was analyzed for total suspended solids, total PCBs, and the following metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Results from these analyses are provided in Table 3. The following quality control (QC) samples were analyzed with the test sample:

- total suspended solids - method blank, laboratory triplicate;
- PCBs - method blank, spike blank, laboratory duplicate, matrix spike, surrogate; and
- metals - method blank, spike blank, laboratory duplicate, matrix spike.

QC sample results were within recommended control limits.

Subsequent discharge monitoring was limited to analysis of settleable solids by Imhoff cone. The industrial permit level of less than 7 mL/L/hr was met. These analyses were performed on-site by construction monitoring personnel.

3.3. CONFIRMATIONAL MONITORING

Confirmational monitoring is performed to confirm the long-term effectiveness of the cleanup action once cleanup standards and other performance standards have been attained (WAC 173-340-410 (c)). Long term confirmation testing is discussed in Appendix G.

3.3.1 Sediment Sampling

Post-dredging sediment samples were collected prior to backfilling and were obtained from three distinctive areas at the cleanup site: a "hotspot;" "upriver" of the hotspot; and "downriver" of the hotspot. These confirmational samples were analyzed for the four chemicals of concern to evaluate whether the dredging effort had removed contaminated sediment to the extent that site sediment chemical concentrations were below the SQS.

During the initial round of confirmational sampling, one composite and three discrete samples were collected from each of the three areas (Figure 5). These initial twelve sediment samples were submitted for analysis of total PCB, 1,4-dichlorobenzene, bis(2-ethylhexyl) phthalate, and mercury along with the sediment conventionals percent solids, total organic carbon (TOC), and particle size distribution (PSD).

Sample location coordinates were specified prior to the initial confirmational sampling event and station positioning was accomplished through use of a shipboard differential global positioning system (DGPS). Sampling protocols and sample acceptability criteria followed guidance specified in *Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound* (PSEP, 1996).

Samples were collected with a 0.1 m^2, stainless steel, modified Van Veen grab sampler deployed via hydrowire from the King County research vessel *Chinook*. Two 10-cm deep sediment aliquots were collected from the center of each grab sample. One aliquot, representing the discrete sample was immediately split into pre-cleaned, labeled sample containers supplied by the analytical laboratory. The second aliquot was placed into a stainless steel bowl and covered with aluminum foil. After the second and third grabs were collected from each area, the three aliquots placed in the stainless steel bowl were composited into a single sample and split into sample containers.

To minimize potential cross-contamination between samples, dedicated stainless steel bowls and spoons were used at each sampling location. The Van Veen grab sampler was decontaminated between samples by washing with a brush and river water, followed by a thorough rinsing. Samples were collected in the order of expected level of contamination with the upriver samples collected first, the downriver samples second, and the hotspot samples collected last.

Samples containers were kept in ice-filled coolers until receipt by the King County Environmental Laboratory. Samples were delivered under chain-of-custody and sample tracking was maintained throughout the analytical process. Results from the confirmational analyses are provided in Table 6.

The PCB chromatograms were reviewed to determine the predominant Aroclor present in the sediment. As with the total PCB results for sediment disposal, the PCB results were felt to be biased high because the results represent a total for each PCB Aroclor that could be present. Review of the chromatograms from the analyses indicated that the PCBs were primarily Aroclor 1016 and/or weathered Aroclor 1248, and contributions from Aroclors 1254 and 1260 were significantly less. The laboratory requantified the results for the final set of confirmational analyses. A comparison of the results is provided in Table 7. Requantification indicates that the data previously reported were biased 40 to 70 percent high.

Based on analytical results from the first round of confirmational sampling (Section 3.3.3), additional dredging was needed in the downriver area and two locations in the hotspot area. During the second round of confirmational sampling, sediment samples were collected at the same three discrete locations in the downriver area and two of the previous discrete locations in the hotspot area. The discrete samples from each of the areas (hotspot and downriver) were composited in a manner similar to the initial round of confirmational sampling. Analysis for these samples was limited to PCBs, chlorobenzenes, and sediment conventionals.

PCB analytical results from the second round of confirmational sampling indicated the need for further dredging to assess the vertical extent of PCB contamination in the downriver and hotspot areas (Section 3.3.3). For the third round of confirmational sampling, sediment samples were collected from three previous locations in the downriver area and two previous locations in the hotspot area. An additional location (hotspot 4) was sampled in the hotspot area from 0 to 12 cm. The sediment from this sample was separated into two samples, one from 0 to 6 cm and a second sample from 6 to 12 cm. These samples were collected to evaluate the potential for dispersal of contaminated sediments during the dredging process. Analysis of samples from the third round of confirmational sampling was limited to PCBs and sediment conventionals .

3.3.2 Sediment Analyses

Confirmational sediment samples were submitted for analysis of PCBs, mercury, bis(2-ethylhexyl) phthalate, 1,4-dichlorobenzene, and the sediment conventionals TOC, total solids, and PSD. All analyses except PSD were performed by the King County Environmental Laboratory. PSD analysis was performed by AmTest, Inc. in Redmond, Washington.

Analytical methodologies are summarized in the following table.

Analyte	Method	Method Summary
PCBs	EPA Method 8082	Gas Chromatography – Electron Capture Detector
Bis(2-ethylhexyl) phthalate	EPA Method 8270	Gas Chromatography - Mass Spectroscopy
1,4-Dichlorobenzene	EPA Method 8270 (SIM)	Gas Chromatography - Mass Spectroscopy (Selected Ion Mode)
Mercury	EPA Method 245.5	Cold Vapor Atomic Absorption Spectroscopy
TOC	SM5310-B	High Temperature Combustion/Infrared Analysis
Total Solids	SM2540-G	Gravimetric
PSD	ASTM D422	Sieve/Hydrometer

All analyses were performed under QA1 guidance (Ecology, 1989) and resulting data underwent QA1 review. The QA review is summarized in the document *Quality Assurance Review for Estuarine Sediment Analytical Data, Norfolk Sediment Cleanup Dredging Project Confirmatory Sampling and Backfill Material Testing* (King County, 1999).

3.3.3 Sample Results

The results of the confirmational sampling are presented in Table 6. A round of confirmational sampling was performed on March 4, 1999. This first round of confirmational tests had total PCB exceedences of the Sediment Quality Standards (SQS) (65 ppm organic carbon normalized [OC]) in the hotspot composite (7,560 ppm OC) and the downriver composite (1,430 ppm OC). The hotspot composite had a 1,4-dichlorobenzene concentration (4.72 ppm OC) that exceeded the SQS (3.1 ppm OC) and the upriver composite had a 1,4-dichlorobenzene concentration (15.4 ppm OC) that exceeded the Cleanup Screening Level (CSL) (9.0 ppm OC). The sediments from the discrete samples that made up the composites were analyzed for total PCB and 1,4-dichlorobenzene, as appropriate to locate a subarea within these larger areas that may be the source of the exceedence. The sample from hotspot 1 did not have concentrations of

1,4-dichlorobenzene above the SQS or CSL but did exceed the CSL for total PCB and had a dry weight concentration of 220 ppm (greater than the TSCA limit of 50 ppm DW). The sample from hotspot 2 had concentrations of 1,4-dichlorobenzene greater than the CSL and of total PCBs greater than the SQS. The sample from hotspot 3 had concentrations of 1,4-dichlorobenzene greater than the SQS but PCBs was not at detectable levels. All three discrete samples from the downriver composite exceeded the CSL with one sample (downriver 2) having a dry weight PCB concentration of 48.5 ppm DW. The discrete sample from upriver 3 had a concentration of 1,4-dichlorobenzene greater than the SQS. The other two upriver discrete samples did not exceed regulatory standards for 1,4-dichlorobenzene. As a result of this round of confirmational sampling, two areas (A and C on Figure 5) were dredged an additional 3 feet with these sediments sent to the hazardous waste landfill at Arlington, Oregon. Areas B and D on Figure 5 were dredged an additional 3 feet with the sediments sent to Olympic View Sanitary Landfill.

A second round of confirmational sampling was then performed in these areas on March 10, 1999. Discrete samples were collected for total PCB analysis from hotspot 1, hotspot 2, downriver 1, downriver 2, and downriver 3 using similar procedures to the first confirmational sampling event. The discrete samples from each area (hotspot and downriver) were composited in a manner similar to the methods used in the two previous rounds of confirmatory sampling. The composite sample from the hotspot exceeded the SQS for 1,4-dichlorobenzene and the CSL for total PCBs. The composite from the downriver area exceeded the CSL for total PCBs. All 5 discrete samples exceeded the PCB CSL with hotspot 1 and downriver 2 both exceeding the TSCA limit of 50 ppm DW. Since PCBs exceeded the CSL in each of these discrete samples further analysis of 1,4-dichlorobenzene was not done. The sampling team observed small globules of "oil" on the surface of these two samples. After discussing the results with representatives of the EBDRP Panel, an additional 3 feet of material was dredged from areas A, B, C, and D identified on Figure 5 with disposal at either Arlington or Olympic View, as appropriate based on PCB concentrations. The Contractor was instructed to 'shave back' the sediments along the bank to try to remove any potential source that may be located in that area. There was concern that the depths of dredging were jeopardizing slope stability in this area.

A third round of confirmational sampling was performed on March 16, 1999. Samples were collected using similar procedures as the other sampling events. Samples were collected from hotspot 1, hotspot 2, downriver 1, downriver 2, downriver 3, and a new location within the hotspot area (hotspot 4) that was located closer to the bank. This location was sampled for the top 12 cm, instead of the usual 10 cm. This grab was subsectioned into two samples, 0 to 6 cm and 6 to 12 cm to determine whether the PCB concentrations were still very high at depth or whether this was a surficial phenomenon, possibly for a pocket source near the bank. All surface samples exceeded the CSL with the samples from downriver 1 and down river 2 exceeding the TSCA limit.

Additional sediments could not be removed from Area C without compromising the stability of the bank near the Boeing outfall. Consultations were held with members of the EBDRP Panel to discuss alternatives. Since a minimum of approximately 9 feet of material had been removed (minimum 3 ft original dredge, two additional 3-foot cuts) and clean backfill would be placed over the entire dredged area to return the site to approximately the original elevation, it was determined that this backfill would act as an environmental cap for any remaining contamination at the site.

4.0 Surveys

4.1 PRE-CONSTRUCTION, POST-DREDGE, AND POST-BACKFILL SURVEYS

King County hired an independent, licensed surveyor (David Evans and Associates) to perform site surveys at key times during the project. Surveys were performed before construction began at the site, after the hotspot was dredged, after the entire area was dredged and after backfilling was completed. These surveys were used to verify that the depths of dredging and elevations for backfilling as required in the Contract Documents were achieved, and were also used as the basis for payment to the Contractor. Each survey was performed using a survey grade fathometer with survey lines approximately every 20 feet across the site. Tidal corrections were made based on periodic reading of tide staffs installed at the site. Horizontal location control was provided by using a differential global positioning system that utilized the Coast Guard corrector station and locally surveyed monuments. The horizontal datum used in the surveys was North American Datum of 1983 with the 1991 update (NAD83 (91)) and the vertical datum was the U.S. Army Corps of Engineers' mean lower low water (MLLW). Copies of five of the surveys performed are included in Appendix E and are the as-builts required by MTCA (WAC 173-340-400(b)).

The pre-dredge survey was performed on July 13, 1998. This survey was used to develop the plans included in the Technical Specifications. A confirmational pre-dredge survey was performed on January 27, 1999. The post-hotspot dredge survey was performed on February 12, 1999. The post-dredge surveys were performed on March 4, 11, and 16, 1999. The post-backfill survey was performed on March 31, 1999.

4.2 CONTRACTOR DAILY PROGESS SURVEYS

The Contractor was required to perform daily progress surveys over the entire area dredged to date during dredging operations. A tag-line method was used for location control. Ranges were set up every 40 feet with tag-line attachment points set on each range. A tag-line made of aircraft cable with crimps placed every 10 feet was used to establish the location of each sounding. Soundings were taken using a calibrated pole. The data were recorded in the field and transferred to a spreadsheet. Typically, only the area dredged on the given day was surveyed. The Contractor also performed a pre-dredge survey on January 25, 1999 to confirm the County's pre-dredge survey. The two surveys were in substantial agreement.

4.3 QUANTITIES

Comparisons between the pre-dredge survey and the post-dredge surveys and post-backfill survey show that 1,900 cy were removed during the hotspot removal phase, 5,190 cy were dredged during the entire project (including the hotspot phase) and 6,700 cy of backfill were placed. These quantities are not necessarily the pay quantities used for the Contractor due to over-dredge, in-fill, and/or over-backfill considerations.

5.0 Deviations From Plans

The following deviations from the Cleanup Study , Engineering Design Report (as amended) and Contract Plans and Technical Specifications were noted:

- The Contractor did not perform daily progress surveys of the entire area dredged to date as required by the Specifications (Section 02482 Part 3.02.A).
- Dredging depth in four areas exceeded the depths required in the Contract Documents to remove additional contaminated sediments detected during confirmational testing (See Section 3.4).

6.0 Post Construction Monitoring

Appendix G includes the Five Year Monitoring Plan for the Norfolk CSO Sediment Remediation Project.

7.0 Affidavit

The remedial action for the contaminated sediments at the Norfolk CSO on the Duwamish River has been completed in substantial compliance with the Engineering Design Report dated November 1997 as amended in August 1998 and the Contract Documents dated October 1998.

Gregory S. Laird, P.E.
Project Manager
Black & Veatch Corporation

8.0 References

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EBDRP. 1995a. *Norfolk Sampling and Analysis Plan, Phase II Addendum.* Prepared for the Elliott Bay/Duwamish Restoration Program Panel by the King County Department of Metropolitan Services (KCDMS). Seattle, Washington. August 1995.

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Appendix A Photos

Photo 1 Temporary Ramp For Loading And Offloading.

Photo2 Barge And Crane In Dredging Position.

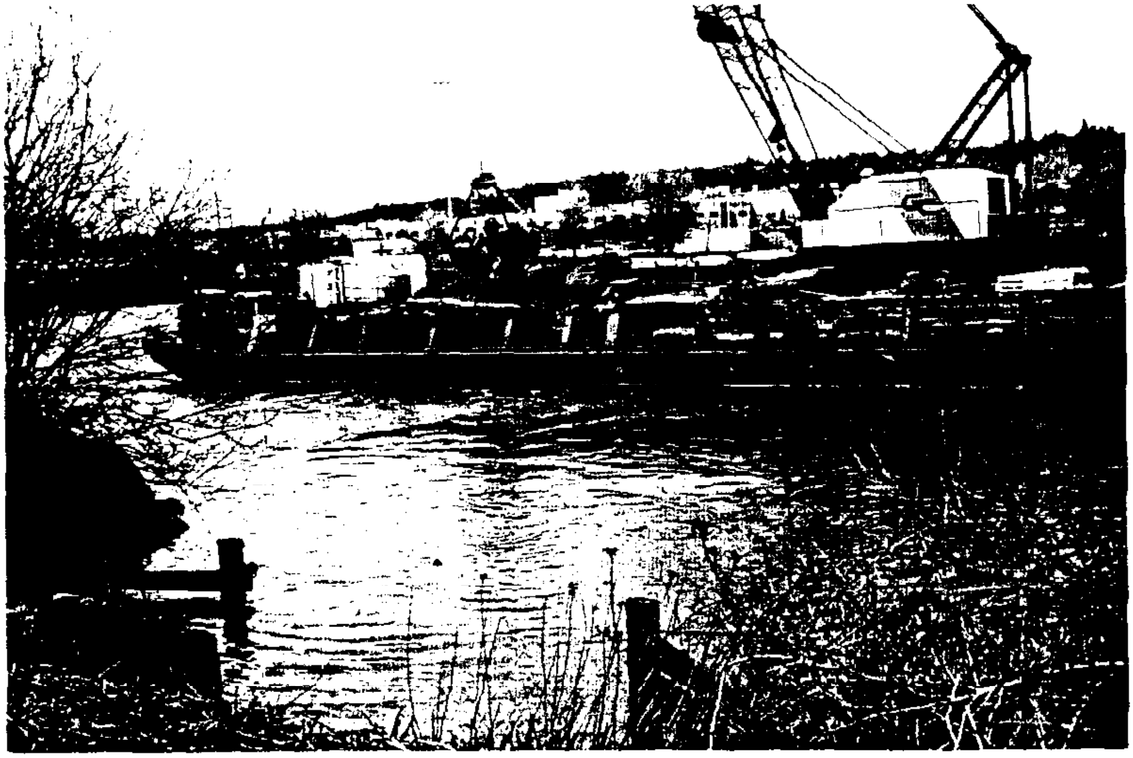

Photo 3 Loading Sediment On Barge.

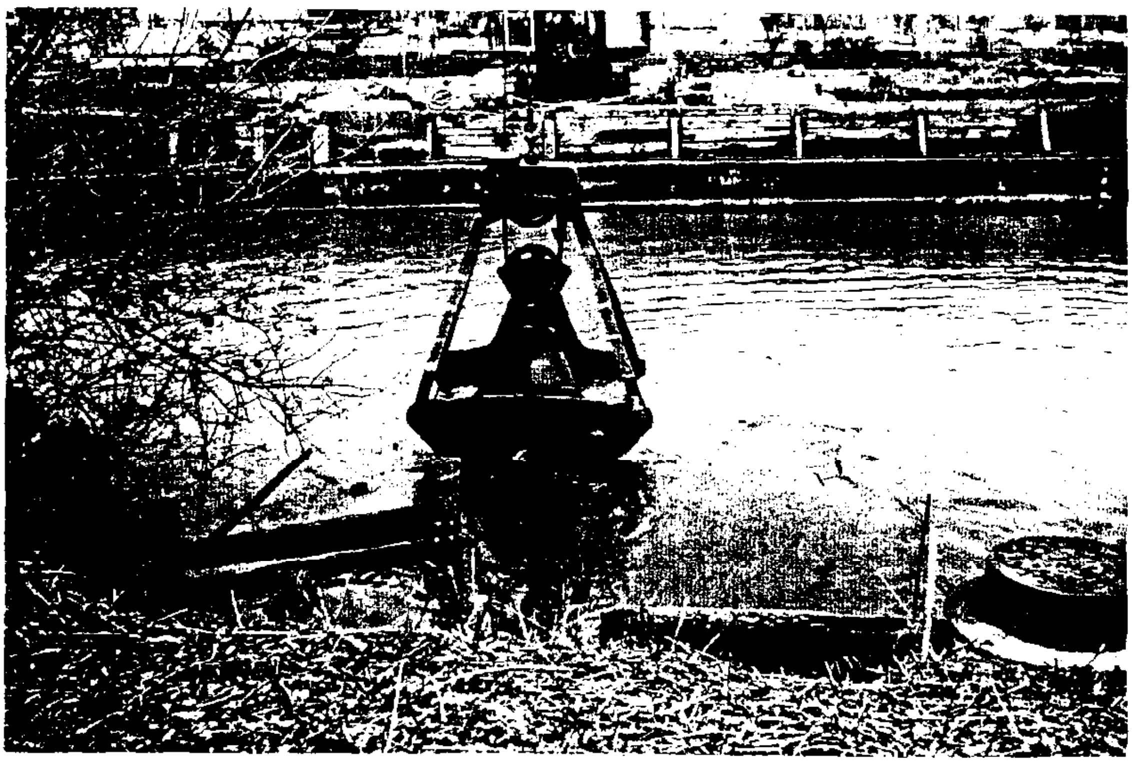

Photo 4 Bucket Guided By Marker Line On Right Side.

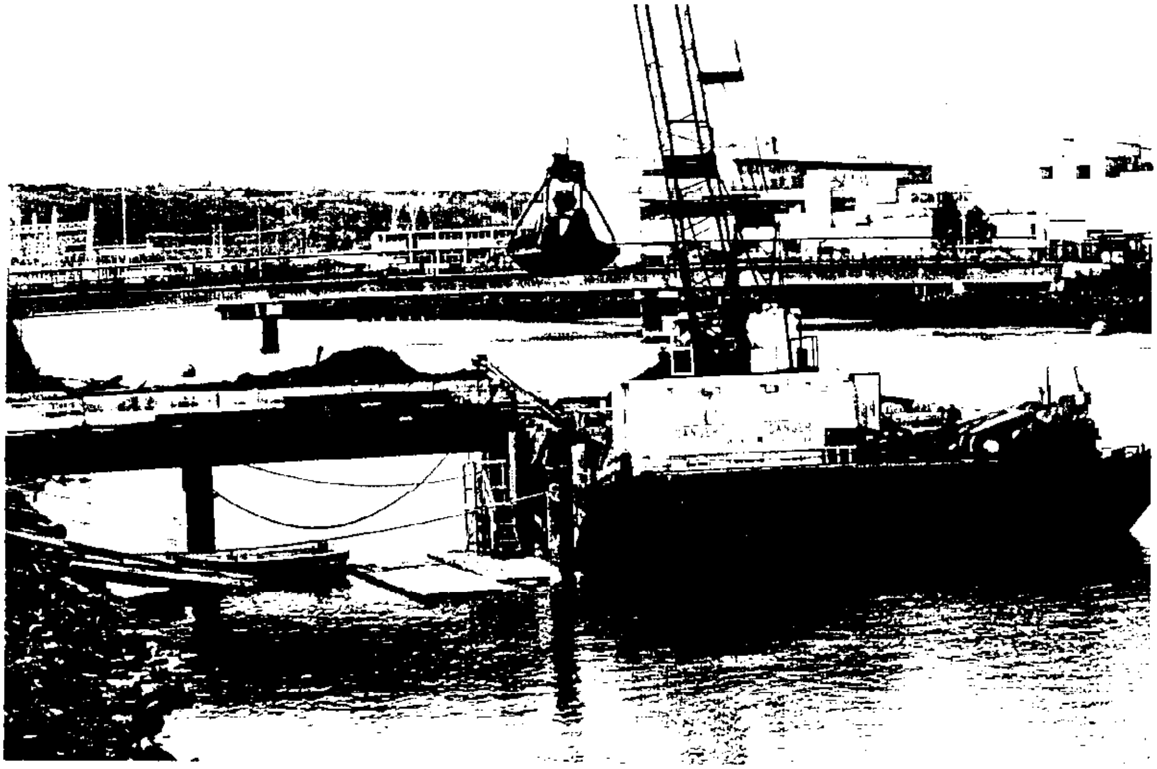

Photo 5 Offloading Sediment At Temporary Ramp.

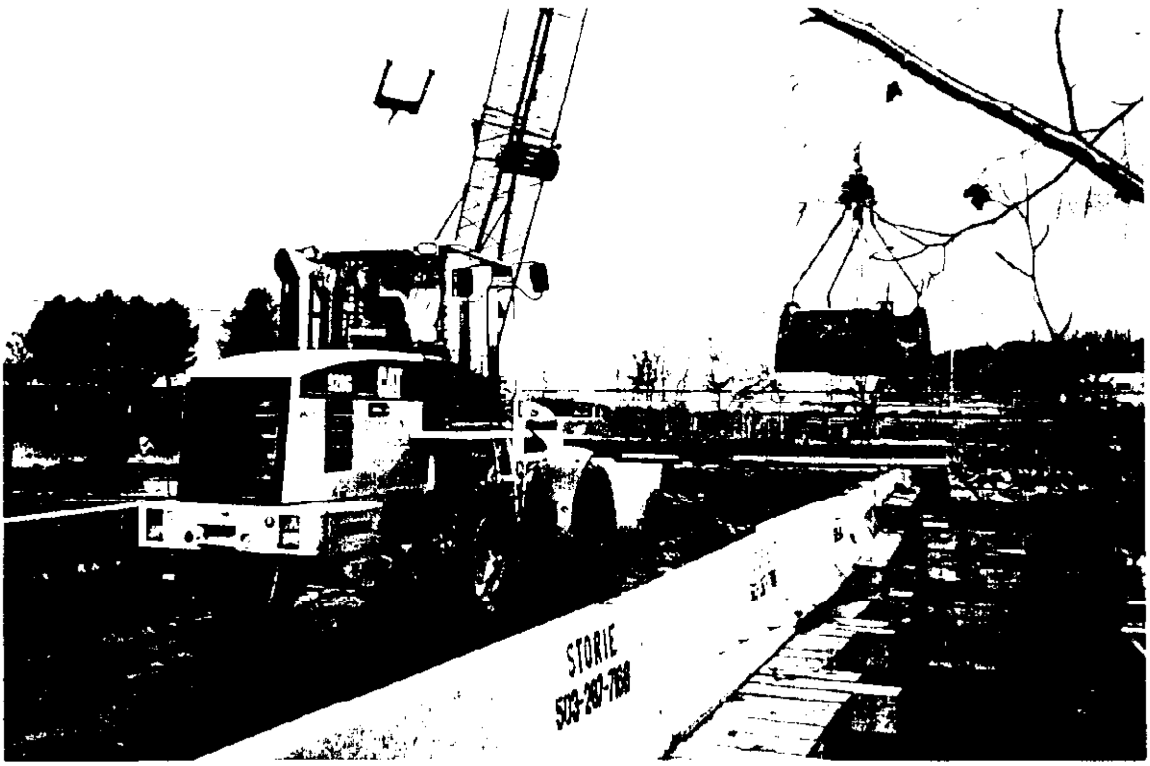

Photo 6 Front-End Loader Picking Up Sediment On Ramp.

Photo 7 Partitions For Sediment And Dewatering Collection System.

Photo 8 Dewatering Area With Sediment In Partitions.

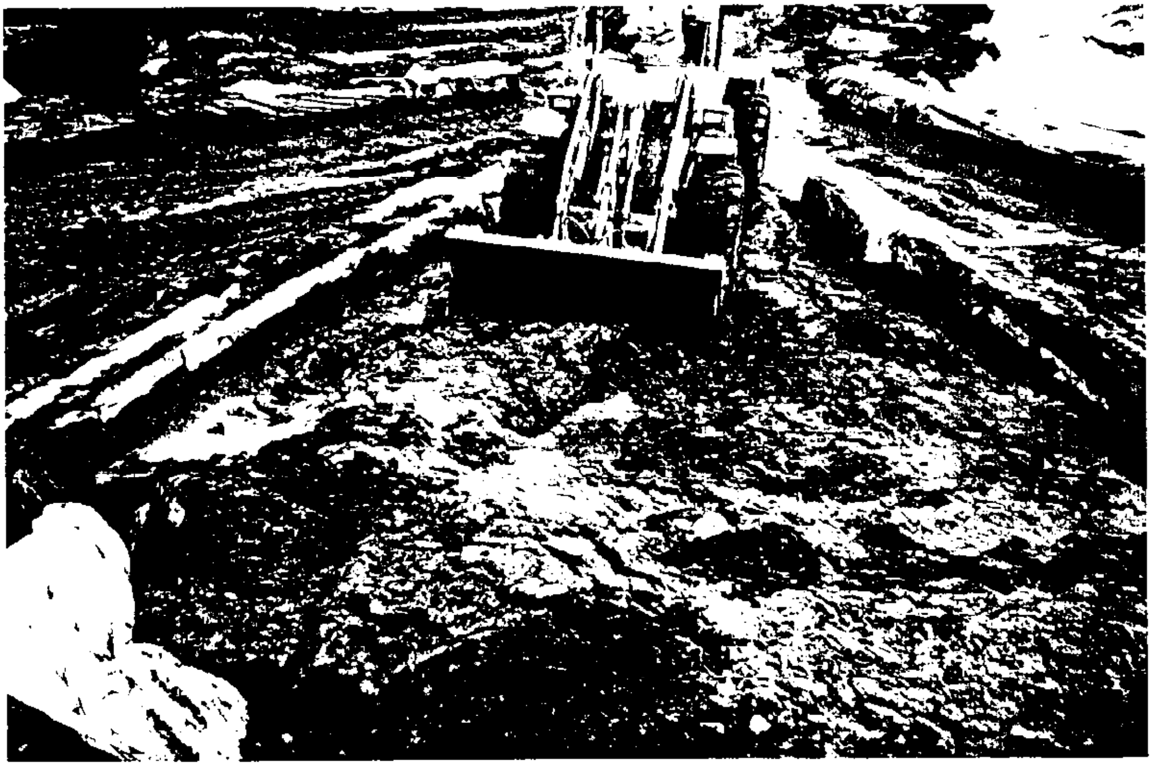

Photo 9 Mixing Fly Ash With Sediment To Absorb Moisture.

Photo 10 Dewatering Area Without Partitions And Loading Lined Trucks.

Photo 11 Woody Debris Taken During Dredging. Note 20,000 Gallon Tank In Background.

Photo 12 Barges With Clean Backfill Came Up River Under Low Bridge.

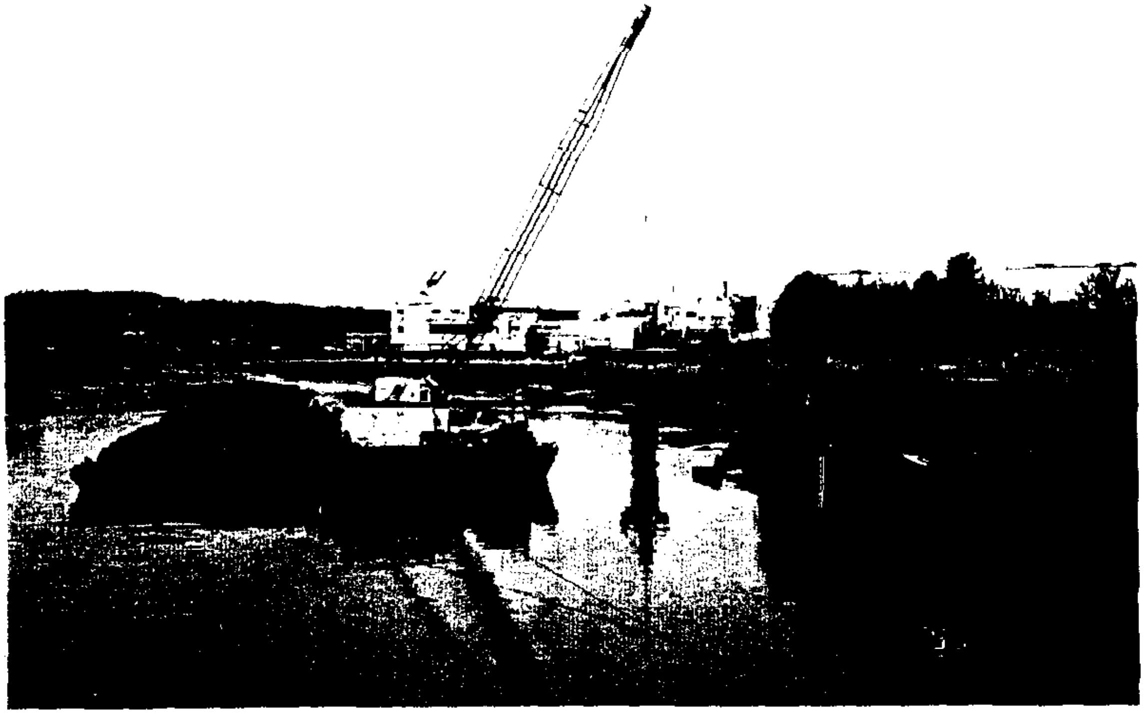

Photo 13 Backfill From Barge Placed With Dredging Crane.

Photo 14 Backfill Placement Near Norfolk CSO Outfall.

Photo 15 Intertidal Backfill Area Shown At Minus 3-Foot Tide.

Photo 16 Decontamination And Cleanup Of Dewatering Area.